**LESSON 7 – APPLICATION EXERCISE 1**
**(Bring a 3.5” computer disk to class)**
*We’ll use an Excel spreadsheet to model horizontal and vertical fights. Which fighter will win?*

**Reading:**
    **“The Problem of the Pullout” Handout**
**Problems/Questions:**
    Work on Problem Set 2
**Objectives:**
    7-1 Understand how Euler’s method can be used to model aircraft performance.
    7-2 Be able to compare an aircraft’s performance in a level turn versus a vertical turn.

**LESSON 8 – APPLICATION EXERCISE 1 CONTINUED**
**(Bring a 3.5” computer disk to class)**
*OK, so modeling something this complex isn’t that quick and easy. You’ll now get a chance to finish up your first application exercise.*

**Reading:**
    **“The Problem of the Pullout” Handout**
**Problems/Questions:**
    Work on Problem Set 2 and Application Exercise 1
**Objectives:**
    8-1 Understand how Euler’s method can be used to model aircraft performance.
    8-2 Be able to compare an aircraft’s performance in a level turn versus a vertical turn.

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| | |
|---|---|
| Last Time: | Entering and leaving a turning fight<br>Last-Ditch Options<br>    Flat/Rolling Scissors<br>Neutral Low-Aspect BFM |
| Today: | Modeling a level turn (7); Modeling a vertical turn (8) |
| Equations: | See last page of these notes |

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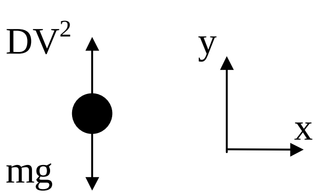
Discuss the Euler method of iterative calculation. Use an example of a ball dropping in a resistive medium.




$$\Sigma F_y = ma_y$$
$$-mg + DV^2 = ma_y$$
$$a_y = -g + DV^2/m$$

For this simple case, let D = 1 kg/m, m = 1 kg, and g = 10 m/s$^2$.

From kinematics, $y = y_0 + v_{y0}\Delta t + ½ a_y(\Delta t)^2$, but $\Delta t$ is small so $(\Delta t)^2$ is negligible and the position equation becomes $y = y_0 + v_{y0}\Delta t$. The velocity equation is simply $v = v_0 + a_y\Delta t$, and the acceleration equation comes from the free body diagram. To solve this, we only need two initial condiditons: the position and velocity at time t = 0.

| Step | Time | Position | Velocity | Acceleration |
|---|---|---|---|---|
| 0 | 0.0 | 0 | 0 | $-g + DV_0^2/m = -10+0=-10$ |
| 1 | 0.1 | $y_0 + v_{y0}\Delta t=0+0=0$ | $v_0 + a_{y0}\Delta t=0+(-10)(0.1)=-1$ | $-g+DV_1^2/m=-10+(1)(1)/(1)=-9$ |
| 2 | 0.2 | $y_1 + v_{y1}\Delta t=0+(-1)(.1)=-.1$ | $v_1 + a_{y1}\Delta t=-1+(-9)(.1)=-1.9$ | $-g+DV_1^2/m=-10+(1)(3.61)/1=-6.39$ |
| n | $n(\Delta T)$ | $y_{n-1} + v_{yn-1}\Delta t$ | $v_{1-1} + a_{yn-1}\Delta t$ | $-g+DV_n^2/m$ |

Show “Level Turn.xls” on the screen. Discuss the blocks and how the specific excess energy is calculated.

PUT THESE UNIT CONVERSIONS ON THE BOARD:

| | | |
|---|---|---|
| 1kt = 0.51479 m/s | 1m = 3.28ft | $g = 9.81\ m/s^2$ |
| timestep = 0.1s | 1NM = 6076ft | 1hr = 3600s |

Speed of sound at 10,000 ft = 328.7 m/s

Formulae for level turn:

Time = (oldtime)+(timestep)
Airspeed = (old airspeed) + (timestep)(acceleration)
Mach = (airspeed)(m/s to kt conversion)(mach/328.7 m/s)
Rate = (load)(g)(deg/rad conversion)/[(airspeed)(kt to m/s conversion)
Avg Rate = (Angle)/(time)
Angle = (old angle) + (timestep)(rate)
Radius = $[(\text{airspeed})(\text{m/s to kt conversion})]^2$(ft to m conversion/[(load)(g)]
Acceleration = (g)(Ps)(sec to hr conversion)/[(airspeed)(m/s to kt conversion)(ft to NM conversion)]
Specific energy = $(\text{airspeed})^2[(\text{m/s to kt conversion})^2(2g)^{-1}$(ft to m conversion] + altitude